# PAR2801-Q32P

## Low-energy Bluetooth 5.0 Module


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# 1 Device Overview

## 1.1 Features

- Qualified Bluetooth Low Energy V5.0 slave device
- Cortex-M0 32-bit MCU with max. 32 MHz clock rate
- Low power and excellent performance 2.4 GHz transceiver
- 2 channels 10-bit SAR ADC
- 128 KB flash, 80 KB SRAM, and 24 KB ROM
- 16 MHz and 32.768 kHz crystal oscillator circuit
- Communication interfaces supported
  - Two I2C master
  - Two 2/4-wire SPI master
  - Two UART
- Digital peripherals
  - Three LED drive IO
  - Three PWM channels
- PCB antenna with 50 ohm impedance and an optional RF pin to connect to an external antenna
- 4 dBm maximum transmitting power
- -93 dBm receiving sensitivity
- No shielding cover

## 1.2 Applications

- HID peripherals
- Health and fitness wearable devices
- Interactive entertainment devices
- Home and industrial automation
- Security / Proximity applications

## 1.3 Descriptions

The PAR2801-Q32P module is a BLE module built around PixArt Cortex-M0 core BLE 5.0 SoC PAR2801 QN-GHVC chip. It integrates 128 KB on-chip flash and 80 KB SRAM. The peripherals include 18 GPIOs multiplexed with PWM, I2C, UART, ADC and SPI interfaces.

## 1.4 Functional Block Diagram

The PAR2801QN-GHVC chip has integrated an ARM® Cortex®-M0 processor, a BLE 4.0 baseband control core ROM, Flash, Bluetooth Modem, Radio Transceiver, on-chip Balun for the BLE application.

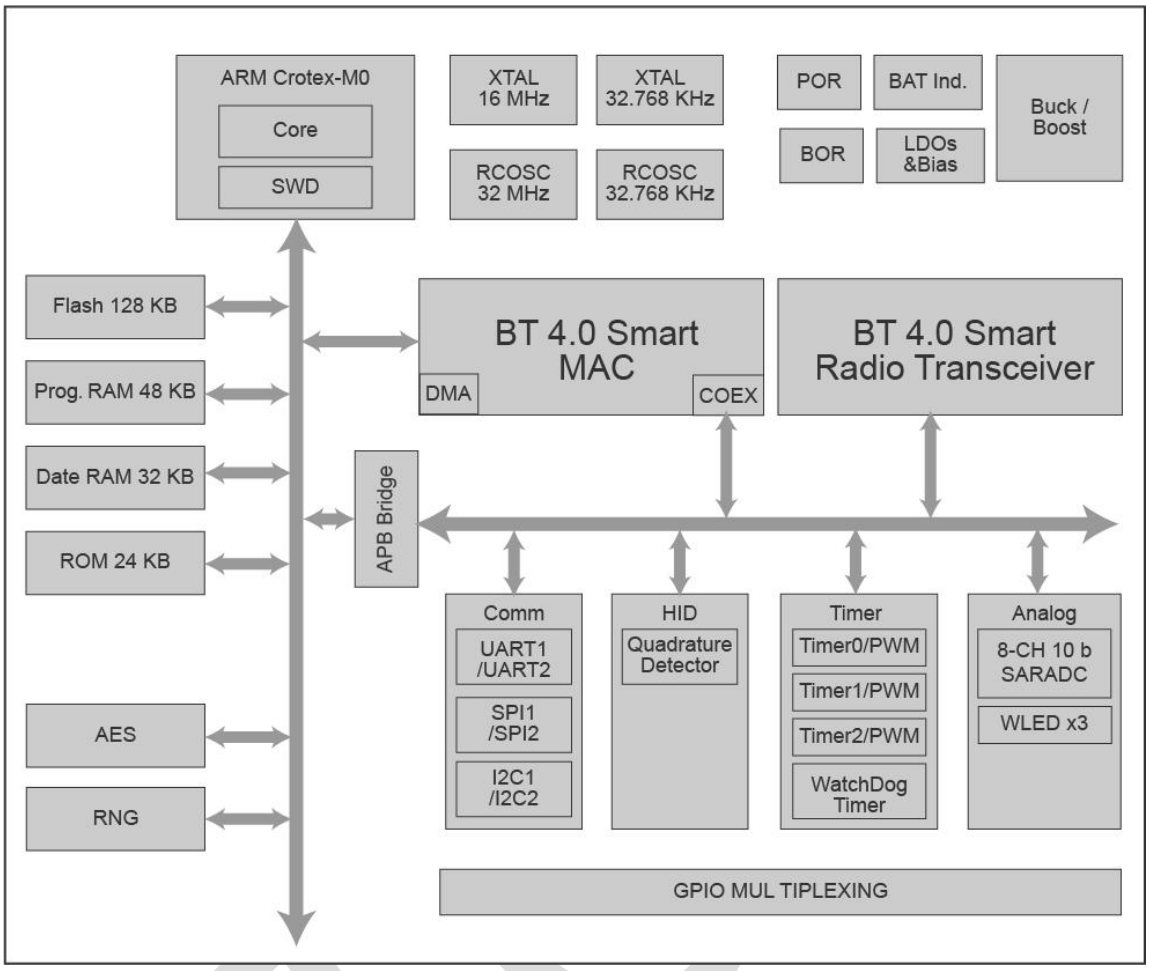



Figure 1. Functional Block Diagram of PAR2801QN-GHVC Chip

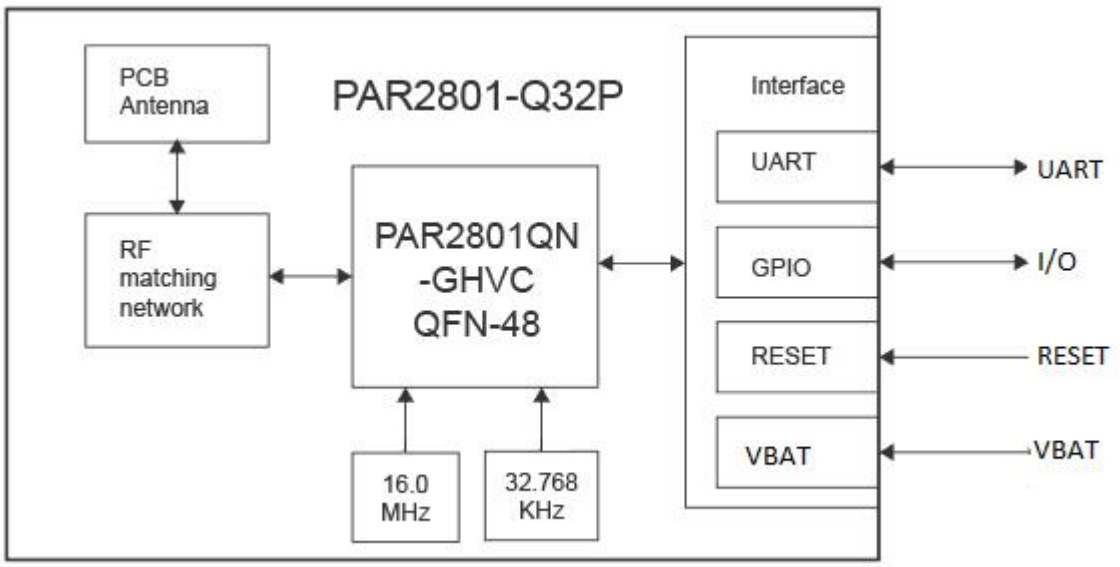



Figure 2. Block Diagram of PAR2801-Q32P

# 2 Pin Configuration and Functions

## 2.1 Module Pin Diagram with Parts Placement

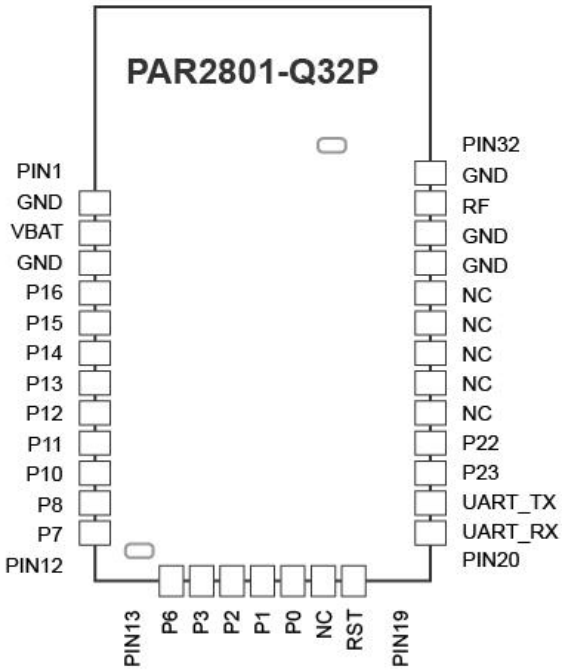



Figure 3. Pin Diagram of PAR2801-Q32P

## 2.2 Pinout Description

### 2.2.1 Pinout Description

| Pin | Name | Pin Type | Description |
|---|---|---|---|
| 1 | GND | Power | Ground |
| 2 | VBAT | Power | Input power pin, connecting to a battery or an external power source. Recommended to add decoupling capacitor, 10 µF. Keep PCB trace as short and wide as possible. |
| 3 | GND | Power | Ground |
| 4 | GPIO16 | BiDir | GPIO, MouseKey_B5, PWM0, or LED0<br>I2C: Data IO, I2C_SDA1 |
| 5 | GPIO15 | BiDir | GPIO, MouseKey_B4, PWM1, or LED1<br>I2C: Clock output, I2C_SCL1 |
| 6 | GPIO14 | BiDir | GPIO, MouseKey_CPI, PWM2, or LED2 |
| 7 | GPIO13 | BiDir | GPIO, MouseKey_Middle |
| 8 | GPIO12 | BiDir | GPIO, MouseKey_Right |
| 9 | GPIO11 | BiDir | GPIO, MouseKey_Left |
| 10 | GPIO10 | BiDir | GPIO, Motion_Wake_Up as motion detect for external sensor, Active |

| | | | |
|---|---|---|---|
| | | | _Low |
| 11 | GPIO8 | BiDir | GPIO<br>SPI4W: Master, Chip Select, SPI_CSN<br>SPI3W: Master, Chip Select, SPI_CSN |
| 12 | GPIO7 | BiDir | GPIO<br>SPI4W: Master, Data_input, SP_DI<br>SPI3W: Master, Data_IO, SPI_DIO<br>I2C: Data_IO, I2C_SDA0 |
| 13 | GPIO6 | BiDir | GPIO<br>SPI4W: Master, Clock output, SPI_CLK<br>SPI3W: Master, Clock output, SPI_CLK<br>I2C: Clock output, I2C_SCL0 |
| 14 | GPIO3 | BiDir | GPIO<br>SPI4W: Master, Data input, SPI_DI_1<br>UART: UART_RTS0 |
| 15 | GPIO2 | BiDir | GPIO, PWM0, or LED0<br>SPI4W: Master, Clock output, SPI_CLK_1<br>UART: UART_CTS0 |
| 16 | GPIO1 | BiDir | GPIO, PWM1, or LED1<br>Analog Input_1<br>I2C: Data IO, I2C_SDA1<br>UART: UART_TXD1 |
| 17 | GPIO0 | BiDir | GPIO, PWM2, or LED2<br>Analog Input_0<br>I2C: Clock output, I2C_SCL0<br>UART: UART_RXD0 |
| 18 | NC | | |
| 19 | RST | In | Active low signal at least 10 ms for HW reset. The module has add a RC POR circuit (R=100 k, C=100 nF) connected to VDDIO power domain. |
| 20 | GPIO26 | BiDir | GPIO, PWM0, or LED0<br>I2C: Clockoutput, as I2C_SCL0,<br>UART: UART_RXD0 |
| 21 | GPIO27 | BiDir | GPIO, PWM2, or LED2<br>I2C: Data IO, as I2C_SDA0<br>UART: UART_TXD0 |
| 22 | GPIO23 | BiDir | GPIO, or Key_Z2<br>I2C: Data IO, as I2C_SDA1<br>UART: UART_TXD1 |
| 23 | GPIO22 | BiDir | GPIO, or Key_Z1<br>I2C: Clock output, I2C_SCL1<br>UART: UART_RXD1 |
| 24 | NC | | |
| 25 | NC | | |

| | | | |
|---|---|---|---|
| 26 | NC | | |
| 27 | NC | | |
| 28 | NC | | |
| 29 | GND | Power | Ground |
| 30 | GND | Power | Ground |
| 31 | RF | BiDir | 2.4 GHz transceiver RF port. Default connected to PCB antenna in the module. |
| 32 | GND | Power | Ground |

### 2.2.2 IO Multiplexing Modes

| GPIO# | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| GPIO0 | GPIO0 | Analog Input0 | | I2C_SCL1 | UART_RXD1 | PWM2/LED2 |
| GPIO1 | GPIO1 | Analog Input1 | | I2C_SDA1 | UART_TXD1 | PW12/LED1 |
| GPIO2 | GPIO2 | M_SPICK_1 | | | UART_CST0 | PWM0/LED0 |
| GPIO3 | GPIO3 | M_SPIDI_1 | | | UART_RTS0 | |
| GPIO6 | GPIO6 | M_SPICK_0 | M_SPICK_0 | I2C_SCL0 | | |
| GPIO7 | GPIO7 | M_SPIDI_0 | M_SPI_IO_0 | I2C_SDA0 | | |
| GPIO8 | GPIO8 | M_SPICSN_0 | M_SPICSN_0 | | | |
| GPIO10 | GPIO10 | MOTION_Wake_UP | | | | |
| GPIO11 | GPIO11 | MouseKey(BL) | | | | |
| GPIO12 | GPIO12 | MouseKey(BR) | | | | |
| GPIO13 | GPIO13 | MouseKey(BM) | | | | |
| GPIO14 | GPIO14 | MouseKey(CPI) | | | | PWM2/LED2 |
| GPIO15 | GPIO15 | MouseKey(B4) | | I2C_SCL1 | | PWM1/LED1 |
| GPIO16 | GPIO16 | MouseKey(B5) | | I2C_SDA1 | | PWM0/LED0 |
| GPIO22 | GPIO22 | MouseKey(Z1) | | I2C_SCL1 | UART_RXD1 | |
| GPIO23 | GPIO23 | MouseKey(Z2) | | I2C_SDA1 | UART_TXD1 | |
| GPIO26 | GPIO26 | | | I2C_SCL0 | UART_RXD0 | PWM0/LED0 |
| GPIO27 | GPIO27 | | | I2C_SDA0 | UART_TXD0 | PWM2/LED2 |

# 3 Specification

## 3.1 Absolute Maximum Rating

| Parameter | Symbol | Min. | Max. | Unit | Note |
|---|---|---|---|---|---|
| VBAT Voltage | $V_{BAT3V}$ | -0.4 | $V_{BAT}$ + 0.3 | V | |
| ESD | $ESD_{HBM}$ | | 2 | kV | Class 2 on all pins, as per human body model. JESD22-A114E with 15 sec internal. |

## 3.2 Recommended Operating Conditions

| Parameter | Symbol | Min. | Typ. | Max. | V | Note |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{BAT3V}$ | 1.9 | 3.0 | 3.6 | V | Including ripples. |
| Storage Temperature | $T_S$ | -40 | - | 85 | ℃ | |
| Operating Temperature | $T_J$ | -20 | - | 70 | ℃ | |

## 3.3 RF Characteristics

### 3.3.1 Transmitter Specification

| Parameters | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Frequency Range | $FR_{TX}$ | | 2402 | - | 2480 | MHz |
| Max. Output Power | $P_{O, MAX}$ | | - | | 4 | dBm |
| Default Output Power | $P_{O, DEF}$ | | | 0 | | dBm |
| Output Power Adjust Range | $P_{O, ADJ}$ | | -30 | | 4 | dBm |
| Output Power Variation | PO, VAR | All channels TX power variation | | 2.0 | | dBm |
| TX 20 dB Bandwidth | $BW_{20dB}$ | | | | 1150 | kHz |
| 1st Adjacent Channel Power | $P_{AJC1}$ | | | | -20 | dBc |
| 2nd Adjacent Channel Power | $P_{AJC2}$ | | | | -40 | dBc |
| Delta F1 Frequency Deviation | $f1_{AVG}$ | | 225 | | 275 | kHz |
| Delta F2 Frequency Deviation | $f2_{AVG}$ | | 185 | | | kHz |
| AVG Delta F2/Delta F1 | $f_{AVG}$ | Δf2AVG/Δf1AVG | 0.8 | | | |
| Frequency Offset | $F_{OFFSET}$ | | -150 | | 150 | kHz |
| Carrier Frequency Drift | $CF_{DRIFT}$ | | | | 50 | kHz |
| Carrier Frequency Drift rate | $CF_{DRIFT\_Rate}$ | | | | 20 | kHz/50 μs |
| 2nd Harmonics Power Level | $Har_{2nd}$ | @Pout = 0 dBm | | | -40 | dBm |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3rd Harmonics Power Level | $Har_{3rd}$ | @Pout = 0 dBm | | | -45 | dBm |

Notes:

Electrical characteristics are measured under BLE specification and recommended operating conditions.

### 3.3.2 Receiver Specification

| Parameters | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Frequency Range | $FR_{TX}$ | | 2402 | - | 2480 | MHz |
| Maximum Input Power | $RX_{MAX}$ | With PER ＜ 30.8% | | 0 | | dBm |
| Ideal Signal Sensitivity | $SEN_{IDEAL}$ | | | -93 | | dBm |
| Dirty Signal Sensitivity | $SEN_{DIRTY}$ | | | -90 | | dBm |
| C/I and Selectivity | | | | | | |
| C/I Co-Channel | $C/I_{CO}$ | | | 9 | | dB |
| C/I Adjacent +1 MHz | $C/I_{1M}$ | | | -1 | | dB |
| C/I Adjacent +2 MHz | $C/I_{2M}$ | | | -35 | | dB |
| C/I Adjacent ≥ +3 MHz | $C/I_{3M}$ | | -40 | -48 | | dB |
| C/I Image Channel | $C/I_{IMG}$ | | | -25 | | dB |
| C/I Image + 1 M Channel | $C/I_{IMG+1M}$ | | | -35 | | dB |
| Inter-Modulation Performance | | | | | | |
| IMD Performance | IMD | 3rd, 4th and 5th offset channel | -24 | | | dBm |
| Blocking Performance | | | | | | |
| Blocking 30 MHz ~ 2000 MHz | $P_{BLK\_30\sim2000MHz}$ | | -10 | | | dBm |
| Blocking 2003 MHz ~ 2399 MHz | $P_{BLK\_2003\sim2399MHz}$ | | -30 | | | dBm |
| Blocking 2484 MHz ~ 2497 MHz | $P_{BLK\_2484\sim2497MHz}$ | | -30 | | | dBm |
| Blocking 3000 MHz ~ 12.75 GHz | $P_{BLK\_3\sim12.75GHz}$ | | -10 | | | dBm |

Notes:

Electrical characteristics are measured under BLE specification and recommended operating conditions.

### 3.4 Power Consumption Summary

| Parameters | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Current @DTM-TX RF | @$V_{BAT3V}$ = 3 V | | 10.0 | | mA |
| Supply Current @ DTM-RX | @$V_{BAT3V}$ = 3 V | | 13.5 | | mA |

# 4 Application, Implementation, and Layout

## 4.1 Application Diagram

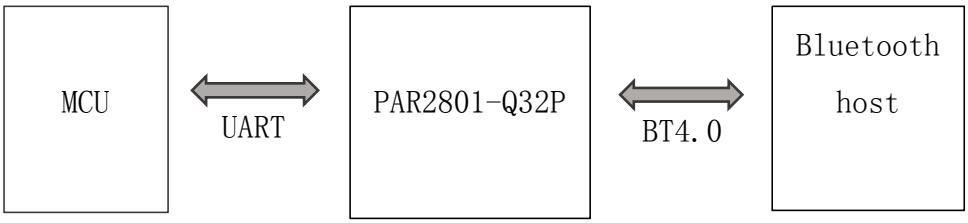



Figure 4. Bluetooth Transmission Application

## 4.2 Typical Application Circuit

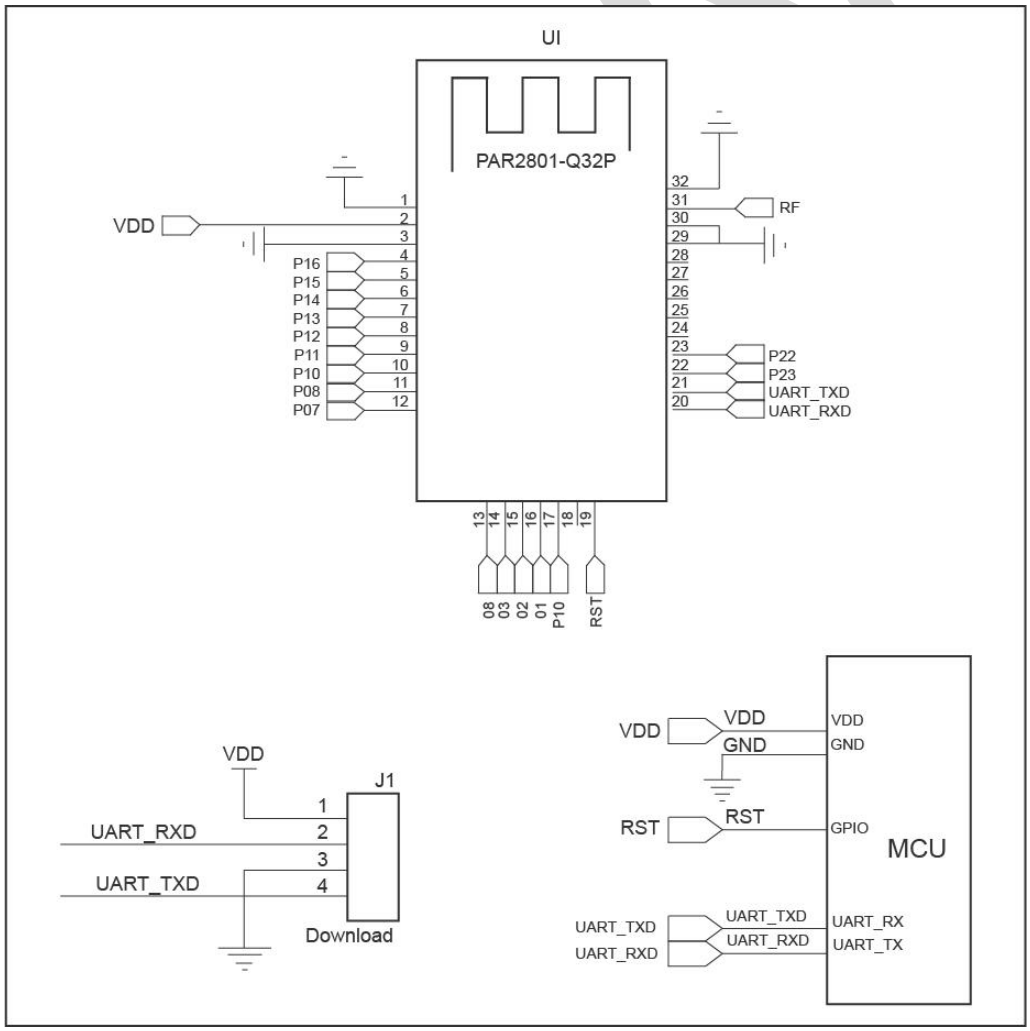



Figure 5. Typical Application Circuit

Note:

VDD: 1.9 V ~ 3.6 V; Recommended VDD: 3.0 V

### 4.3 Layout Guideline

1. It is recommended to place the module at the edge of the main board. The PCB antenna should be oriented towards the outside of the board and away from interference sources such as DC-DC.

2. The PCB antenna area in the main board should be free of all layers of copper, and there should be no wiring.

## 5 Mechanical and Package

### 5.1 Recommended PCB Footprint

L: 12.20 mm±0.13 mm； W: 21.00 mm±0.13 mm; H:1.8 mm±0.2 mm

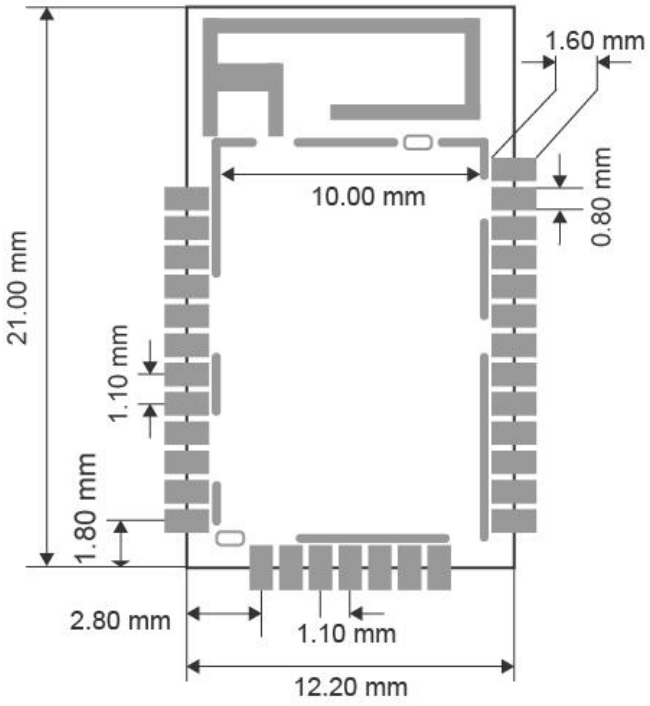



Figure 6. Recommended PCB Footprint of PAR2801-Q32P

### 5.2 Package Information

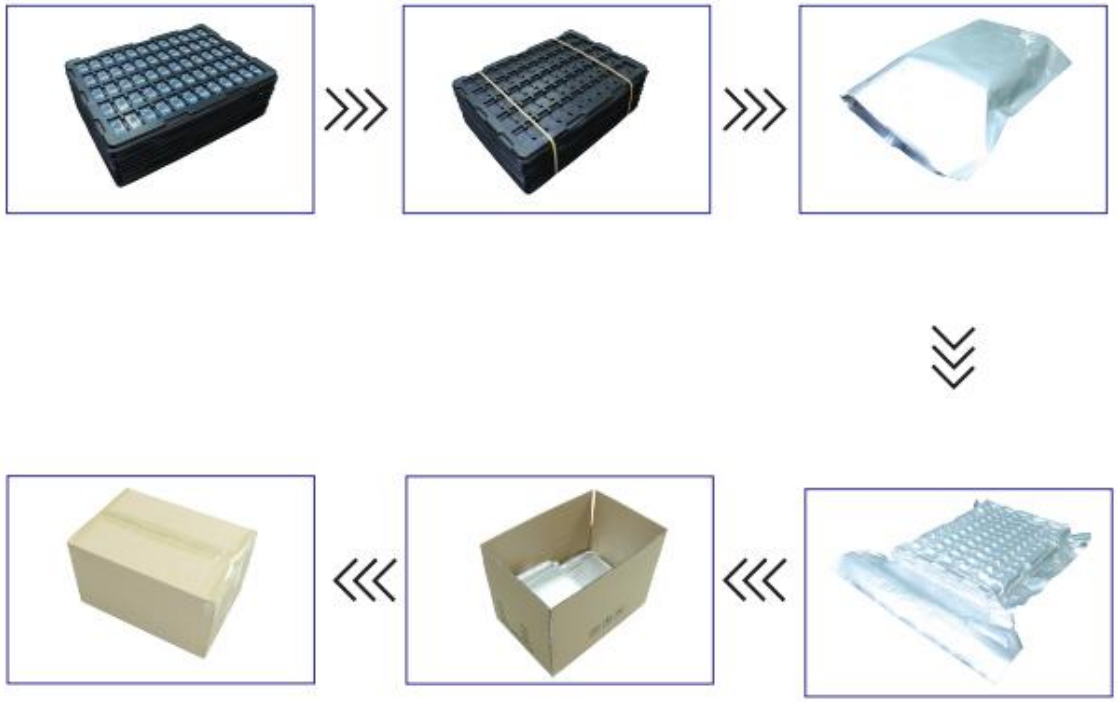


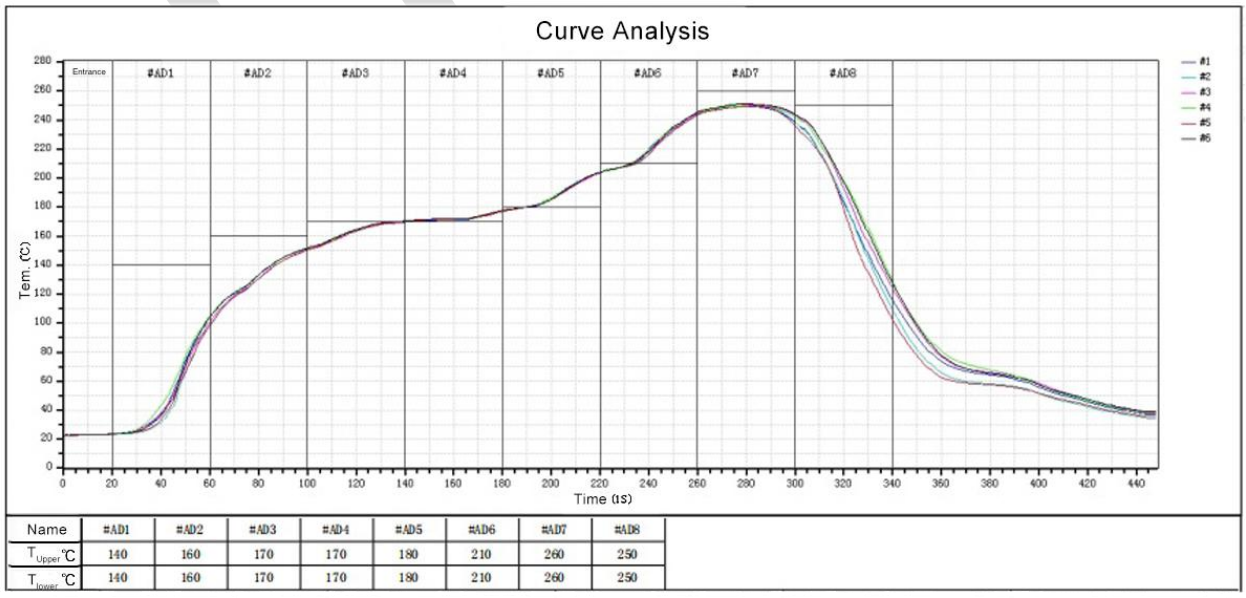
Figure 7. Brief Packaging Process of PAR28011-Q32P Modules

## 6 Thermal Reflow

Referred to IPC/JEDEC standard.

Peak temperature: <250 °C

Number of times: ≤2




| Name | #AD1 | #AD2 | #AD3 | #AD4 | #AD5 | #AD6 | #AD7 | #AD8 |
|---|---|---|---|---|---|---|---|---|
| $T_{Upper}$ ℃ | 140 | 160 | 170 | 170 | 180 | 210 | 260 | 250 |
| $T_{lower}$ ℃ | 140 | 160 | 170 | 170 | 180 | 210 | 260 | 250 |

Figure 8. Recommended Reflow for Lead Free Solder

Note: The module is recommended not to go through reflow oven twice.

## 7 Revision History

| Version | Change Content | Reviser | Date |
|---|---|---|---|
| V1.0 | The initial version | Lei Wang | 2018.11.02 |
| V1.1 | Updated Bluetooth version | Lei Wang | 2019.04.26 |
| V1.2 | Modified English version | Lei Wang | 2019.08.08 |
| V1.3 | Updated the block diagram and application diagram of the module | Lei Wang | 2019.11.11 |
| V2.0 | Changed the Storage Temperature | Lei Wang | 2020.06.01 |
| | | | |

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